US009620550B2

(12) **United States Patent**
Chang et al.

(10) **Patent No.: US 9,620,550 B2**
(45) **Date of Patent: Apr. 11, 2017**

(54) **BACKSIDE ILLUMINATED IMAGE SENSOR STRUCTURE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/935,861**

(22) Filed: **Nov. 9, 2015**

(65) **Prior Publication Data**

US 2016/0064433 A1 Mar. 3, 2016

Related U.S. Application Data

(62) Division of application No. 14/099,481, filed on Dec. 6, 2013, now Pat. No. 9,209,339.

(51) **Int. Cl.**

H01L 27/146	(2006.01)
H01L 31/0232	(2014.01)
H01L 31/18	(2006.01)

(52) **U.S. Cl.**
CPC ***H01L 27/1464*** (2013.01); ***H01L 27/14621*** (2013.01); ***H01L 27/14623*** (2013.01); ***H01L 27/14627*** (2013.01); ***H01L 27/14636*** (2013.01); ***H01L 27/14685*** (2013.01); ***H01L 31/02327*** (2013.01); ***H01L 31/18*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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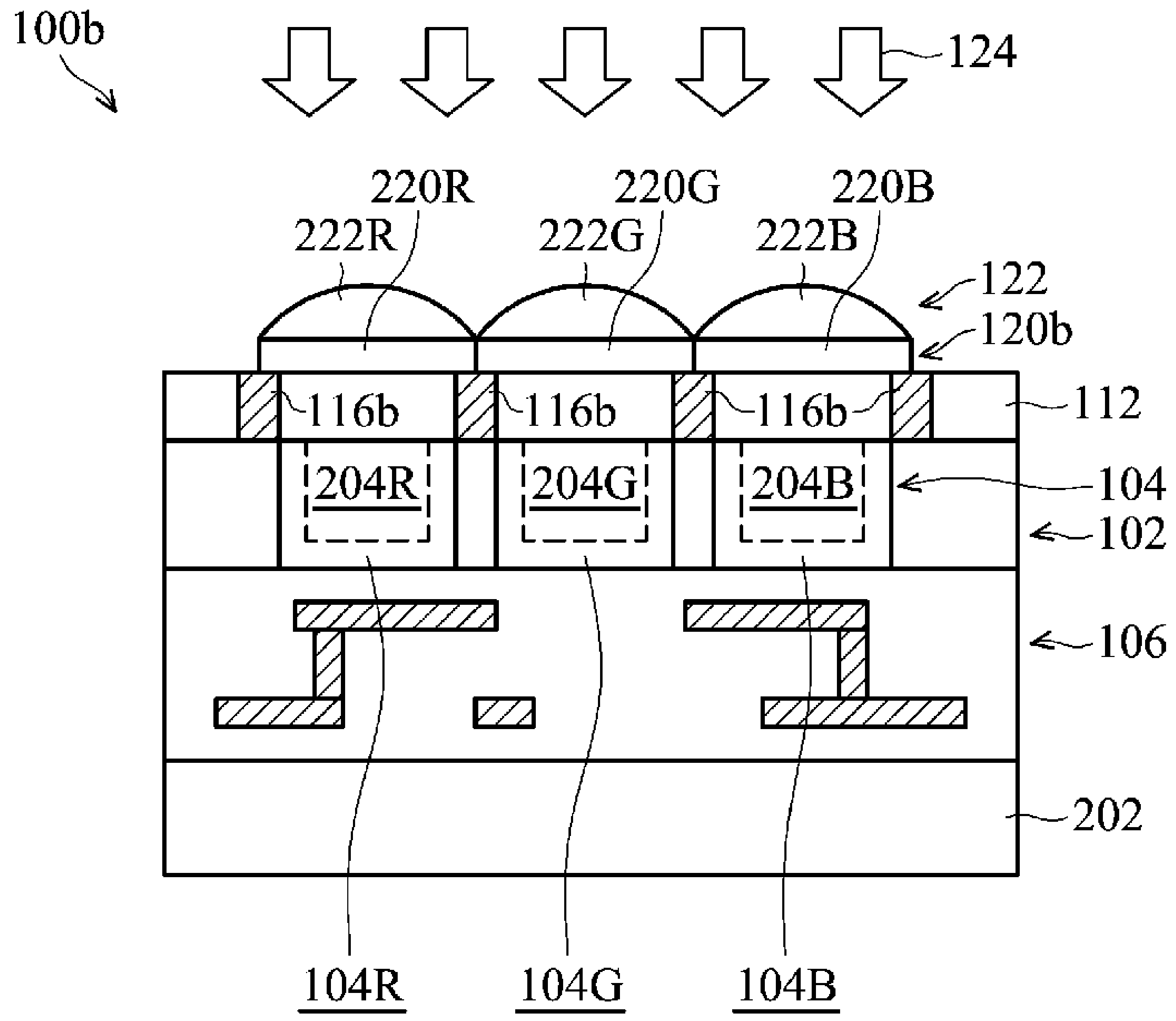
(57) **ABSTRACT**

Backside illuminated image sensor structures are provided. The backside illuminated image sensor structure includes a device substrate having a frontside and a backside and pixels formed at the frontside of the substrate. The backside illuminated image sensor structure further includes a metal element formed in a dielectric layer over the backside of the substrate and a color filter layer formed over the dielectric layer. In addition, the metal element is configured to form a light blocking area in the device substrate and is made of copper.

17 Claims, 8 Drawing Sheets



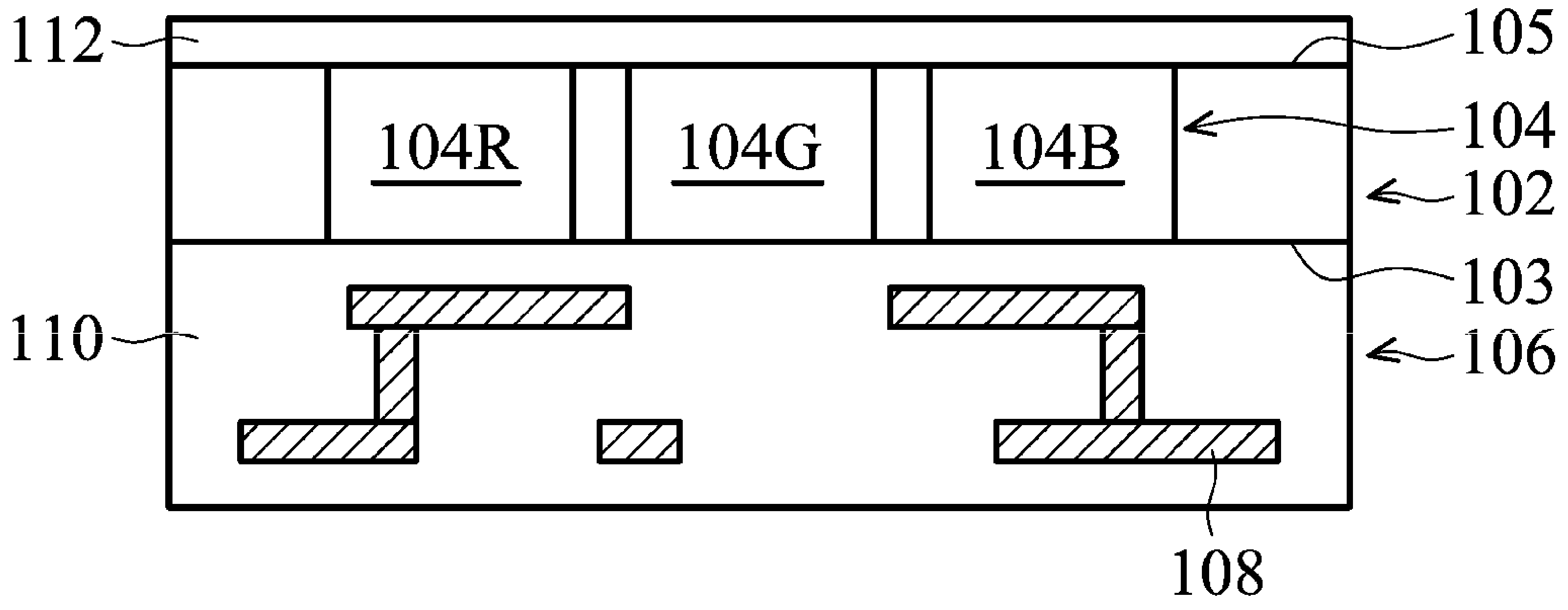
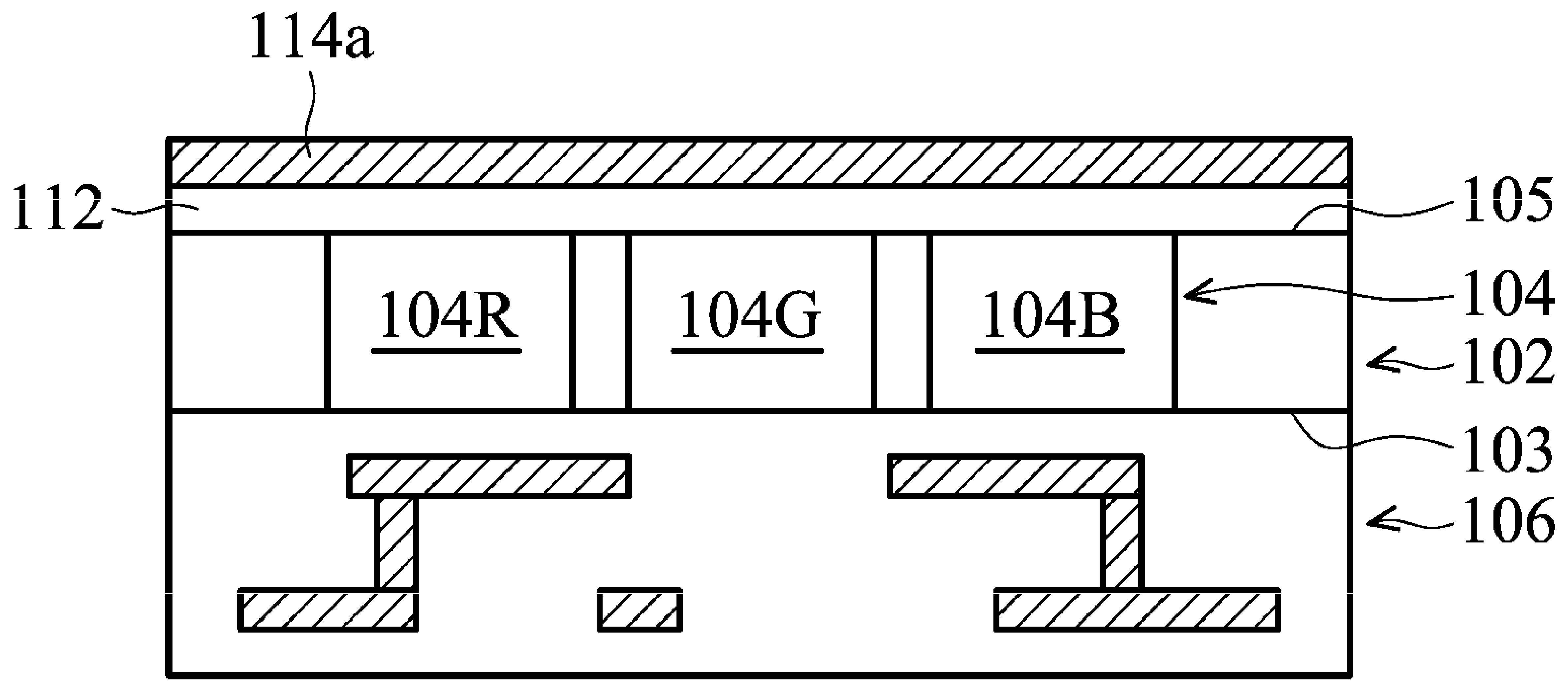

112
105
104R
104G
104B
104
102
103
110
106
108

FIG. 1A


114a
112
105
104R
104G
104B
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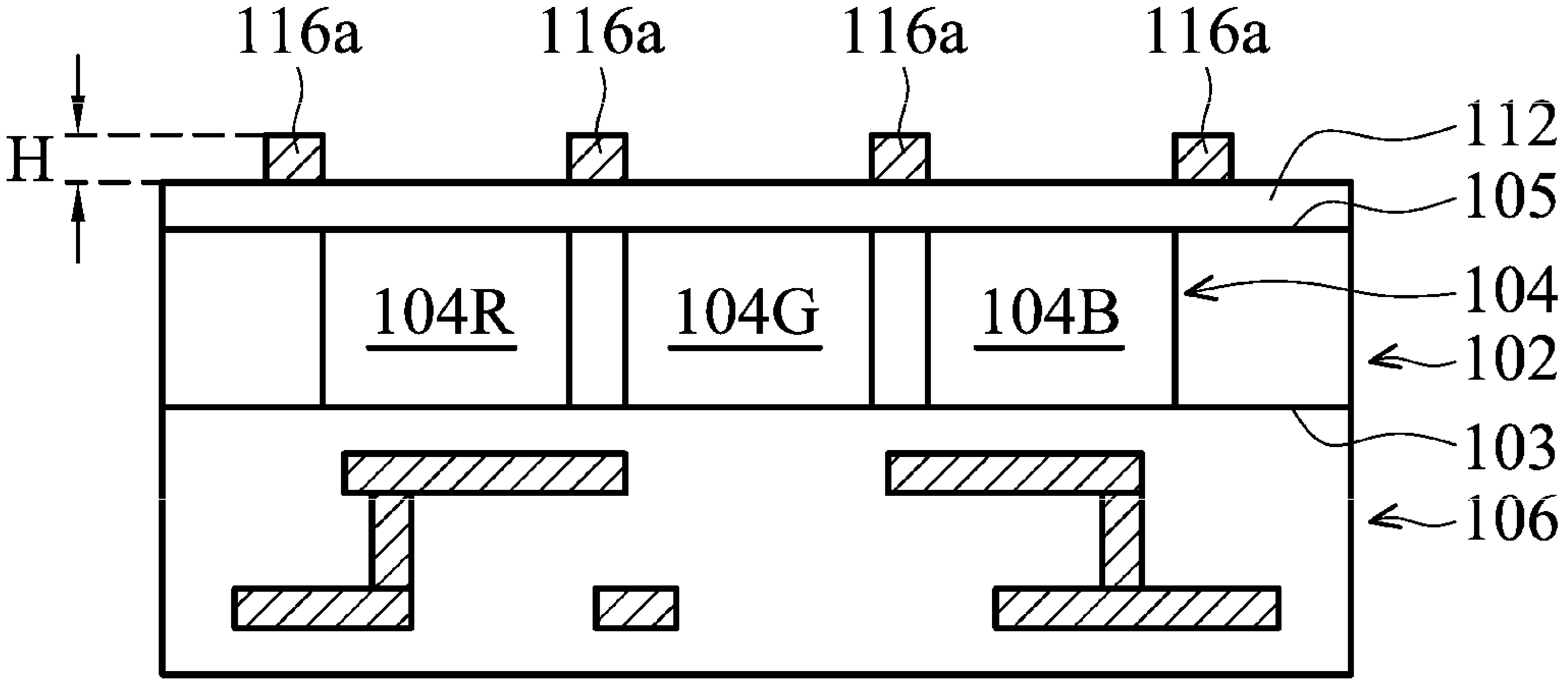
102
103
106

FIG. 1B


116a
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116a
H
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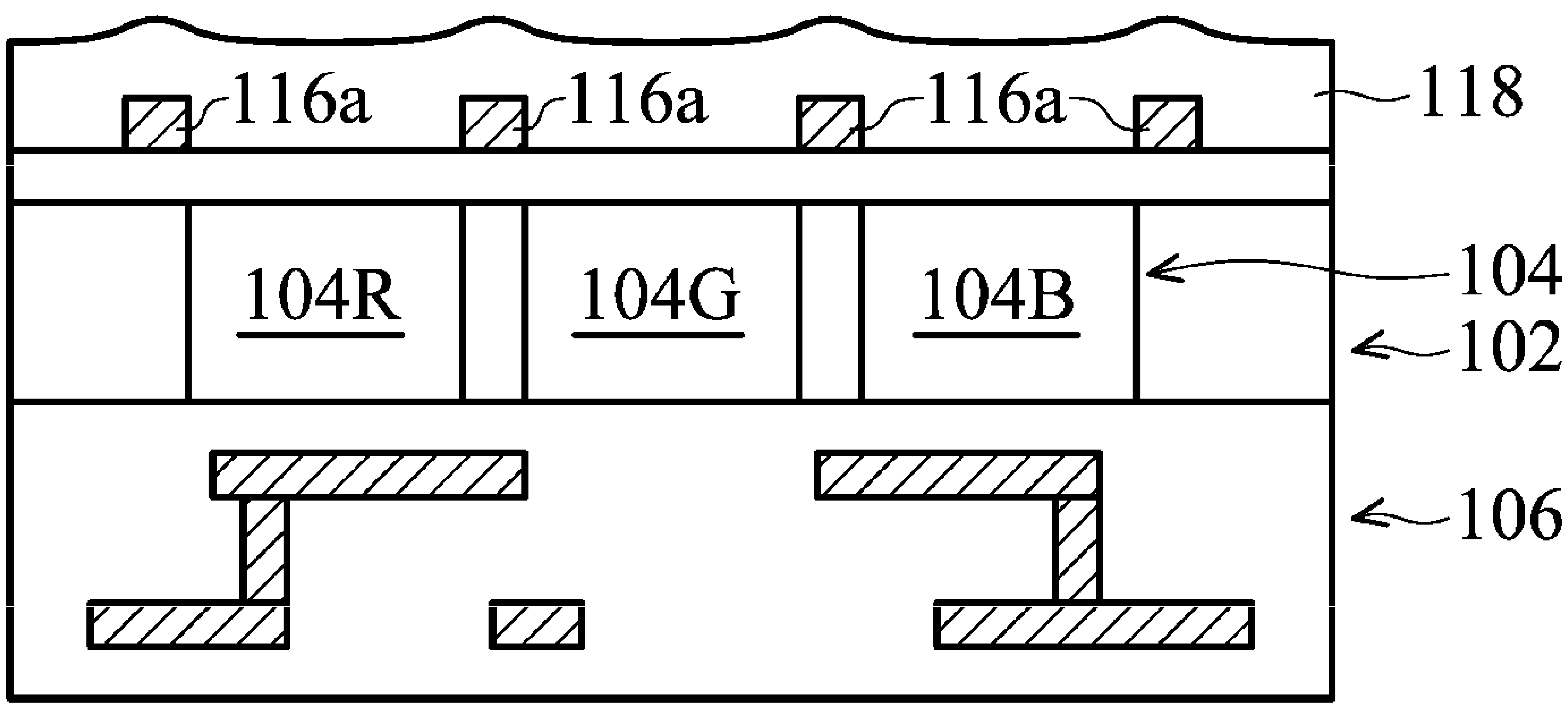
104R
104G
104B
104
102
103
106

FIG. 1C


116a
116a
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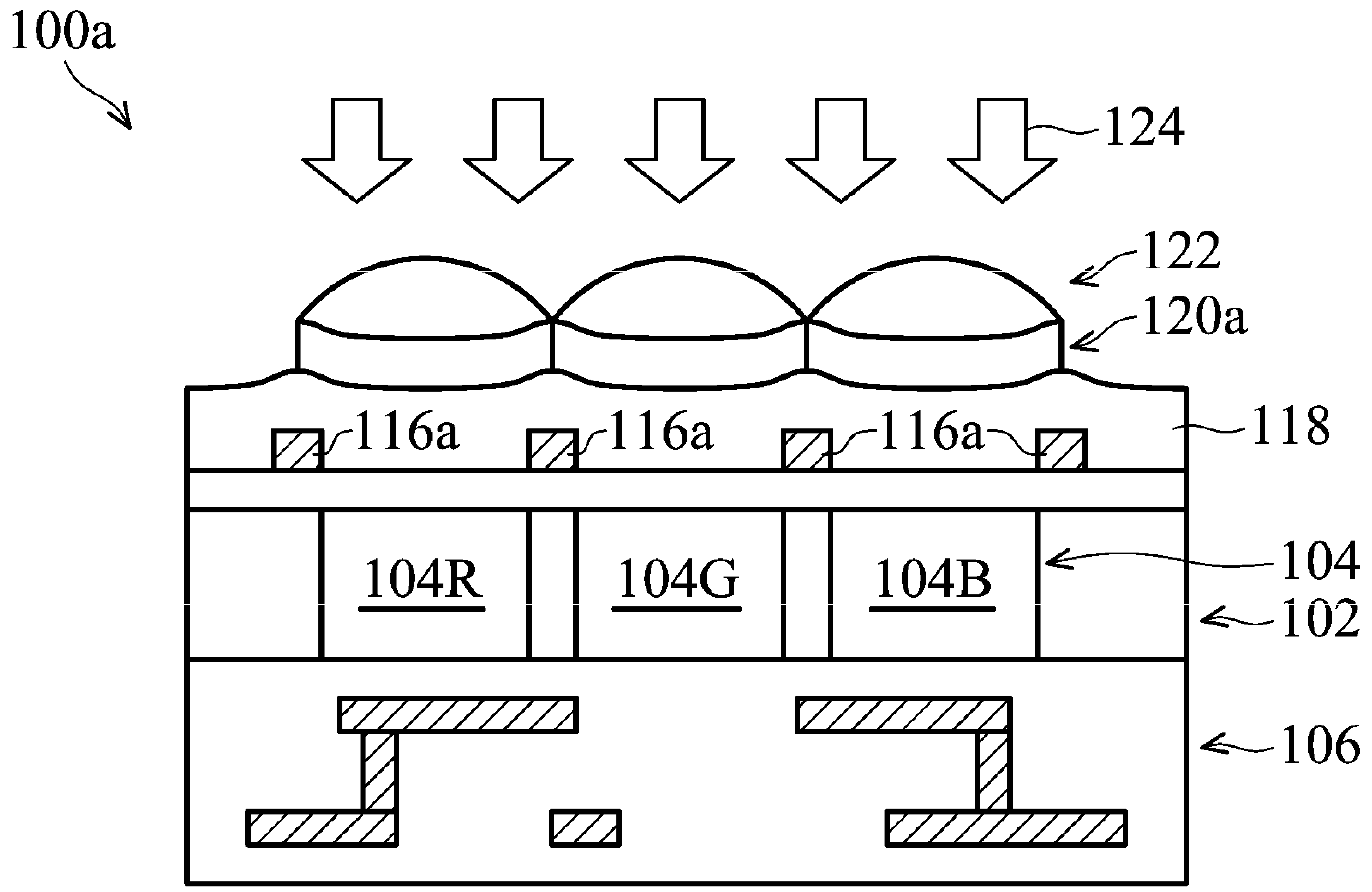
118
104R
104G
104B
104
102
106

FIG. 1D


100a
124
122
120a
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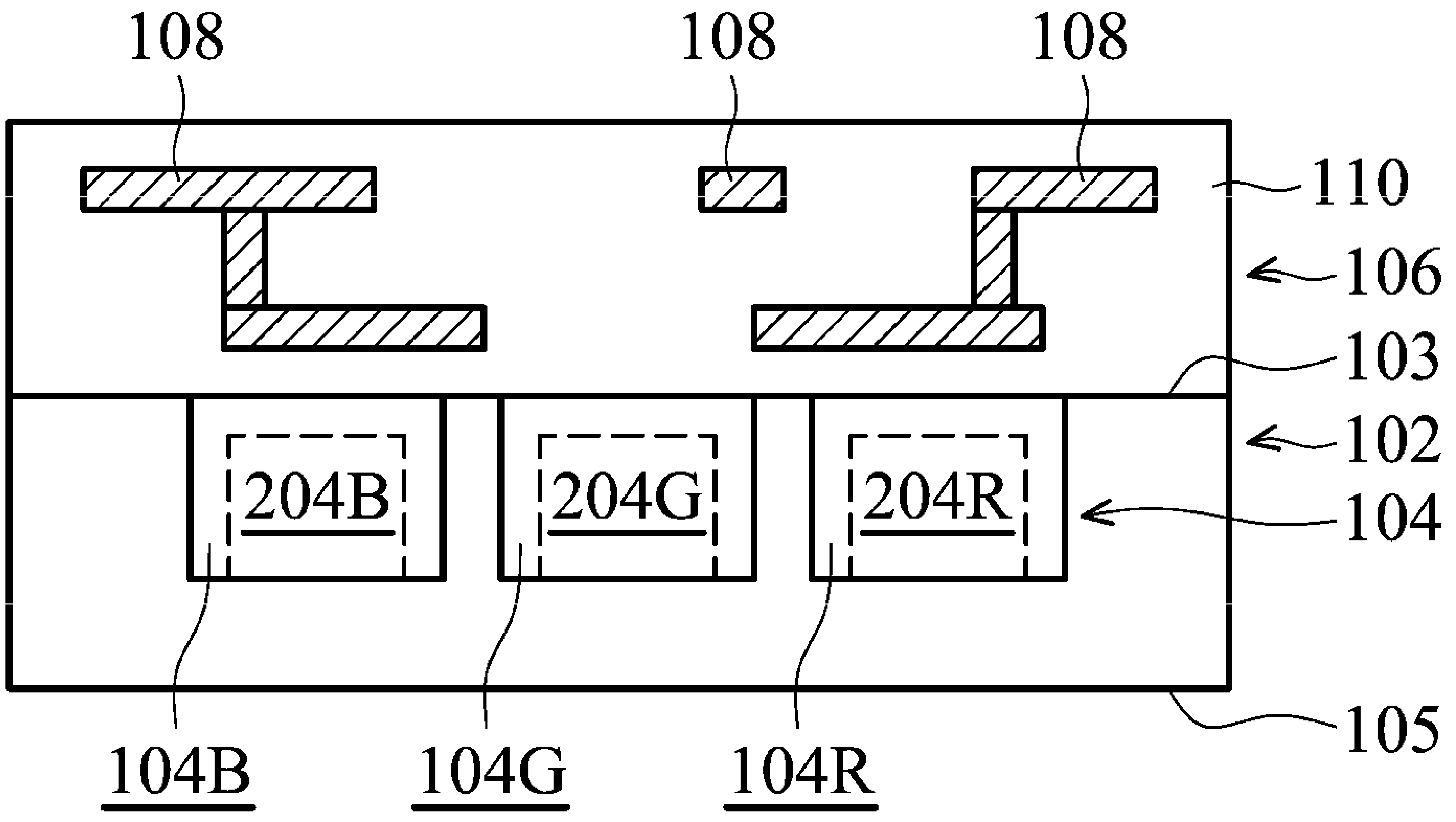
116a
116a
118
104R
104G
104B
104
102
106

FIG. 1E


108
108
108
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102
204B
204G
204R
104
105
104B
104G
104R

FIG. 2A

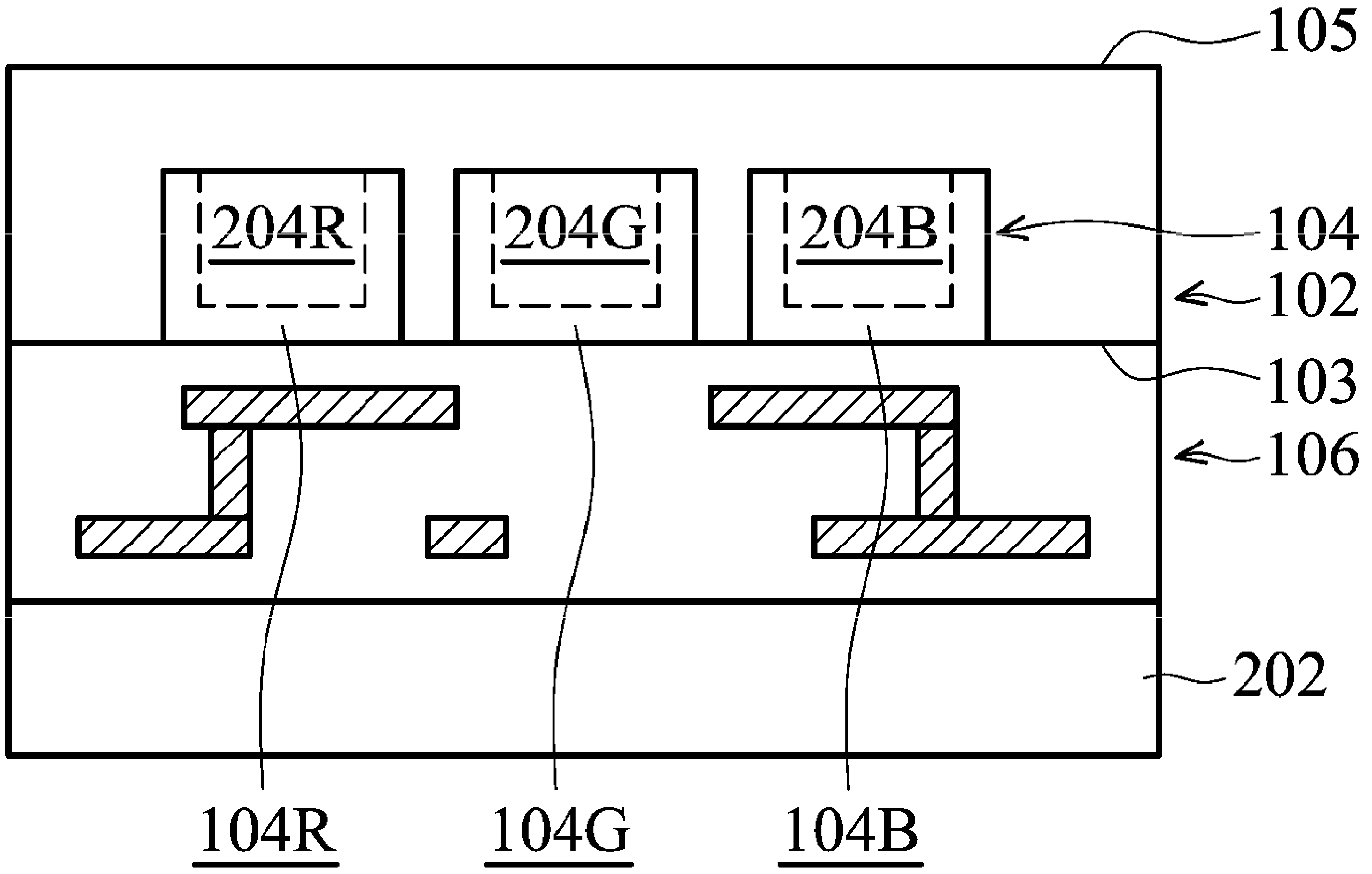
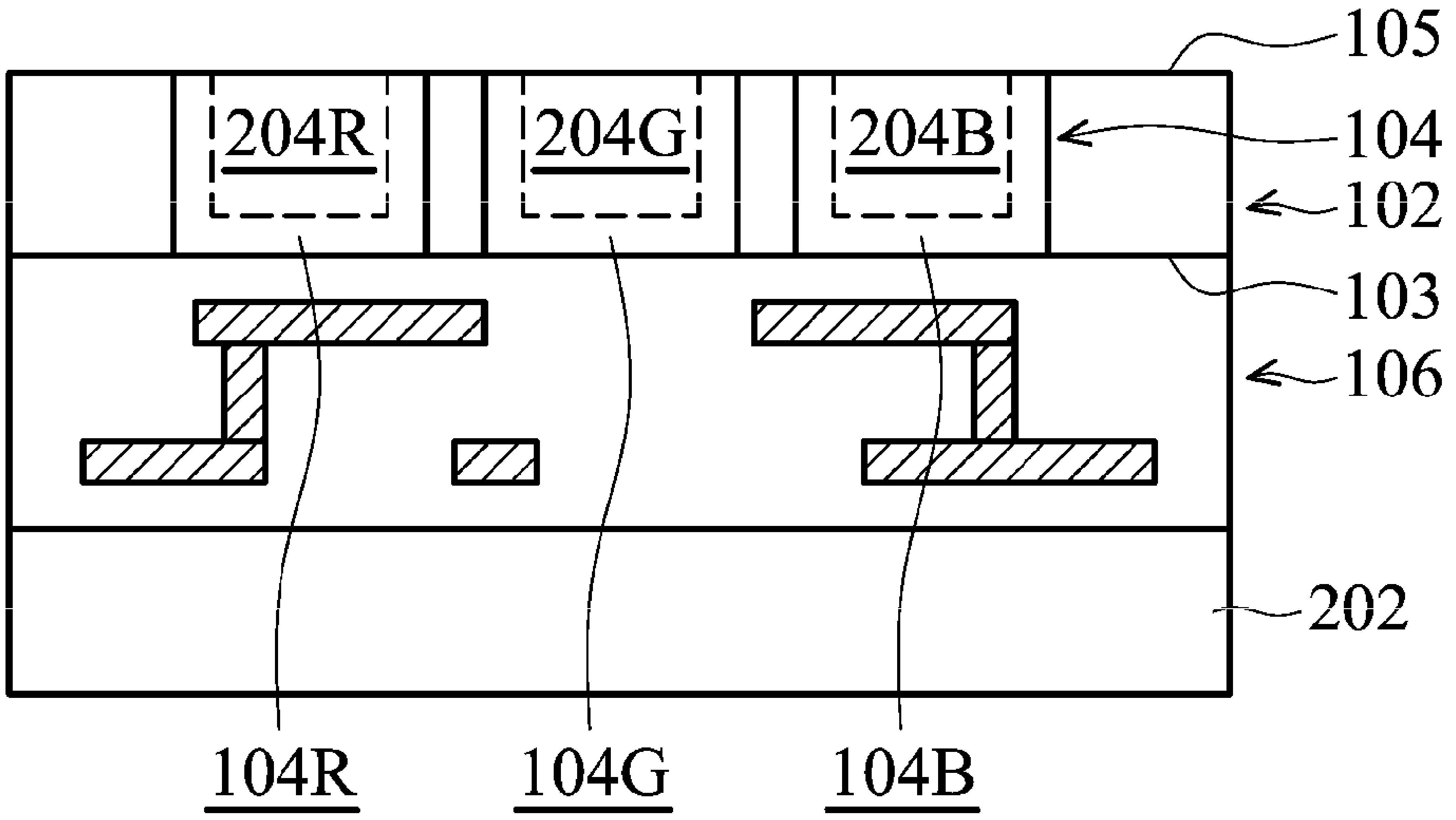

105
204R
204G
204B
104
102
103
106
202
104R
104G
104B

FIG. 2B


105
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204B
104
102
103
106
202
104R
104G
104B

FIG. 2C

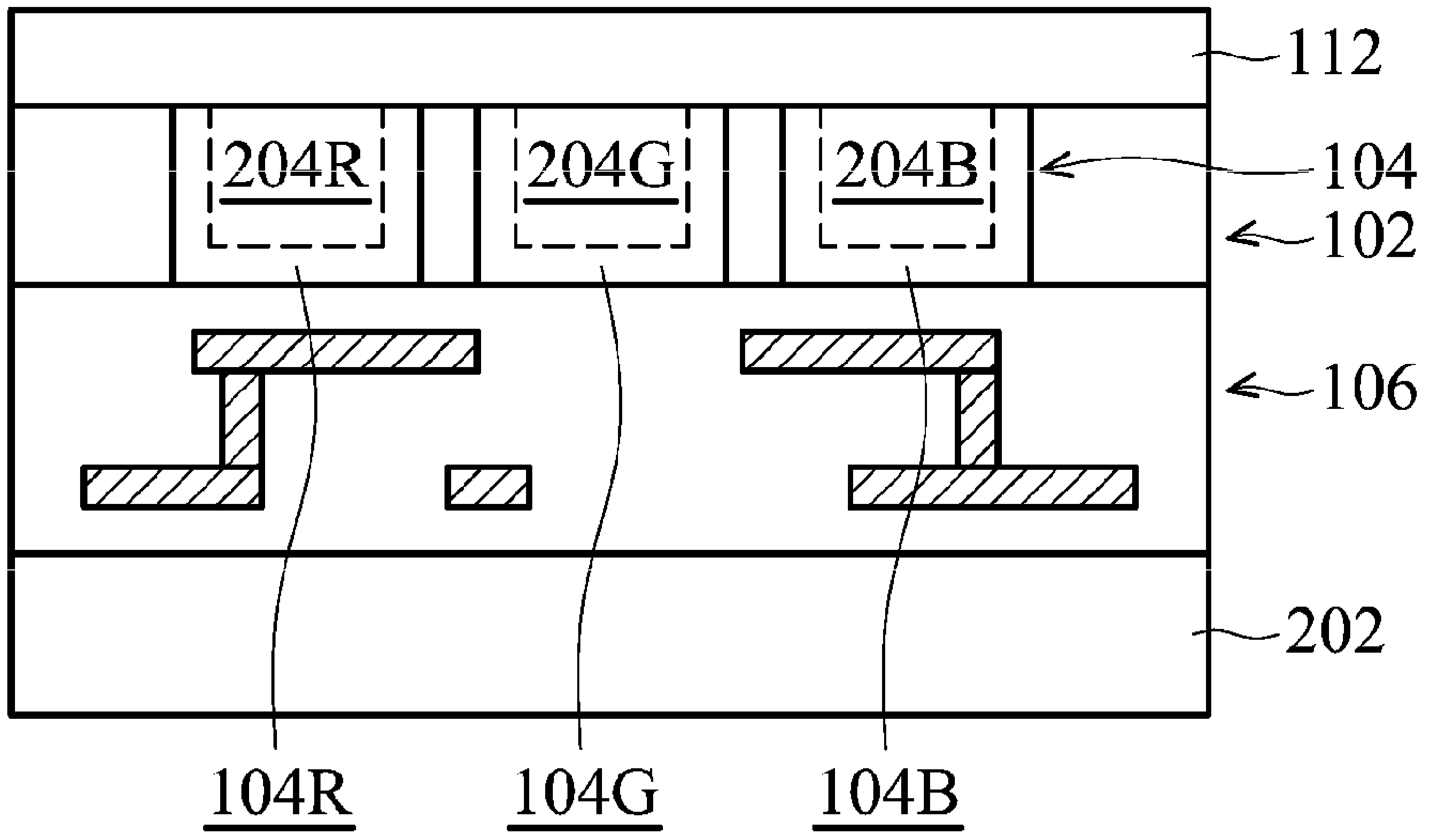
112
204R
204G
204B
104
102
106
202
104R
104G
104B

FIG. 2D

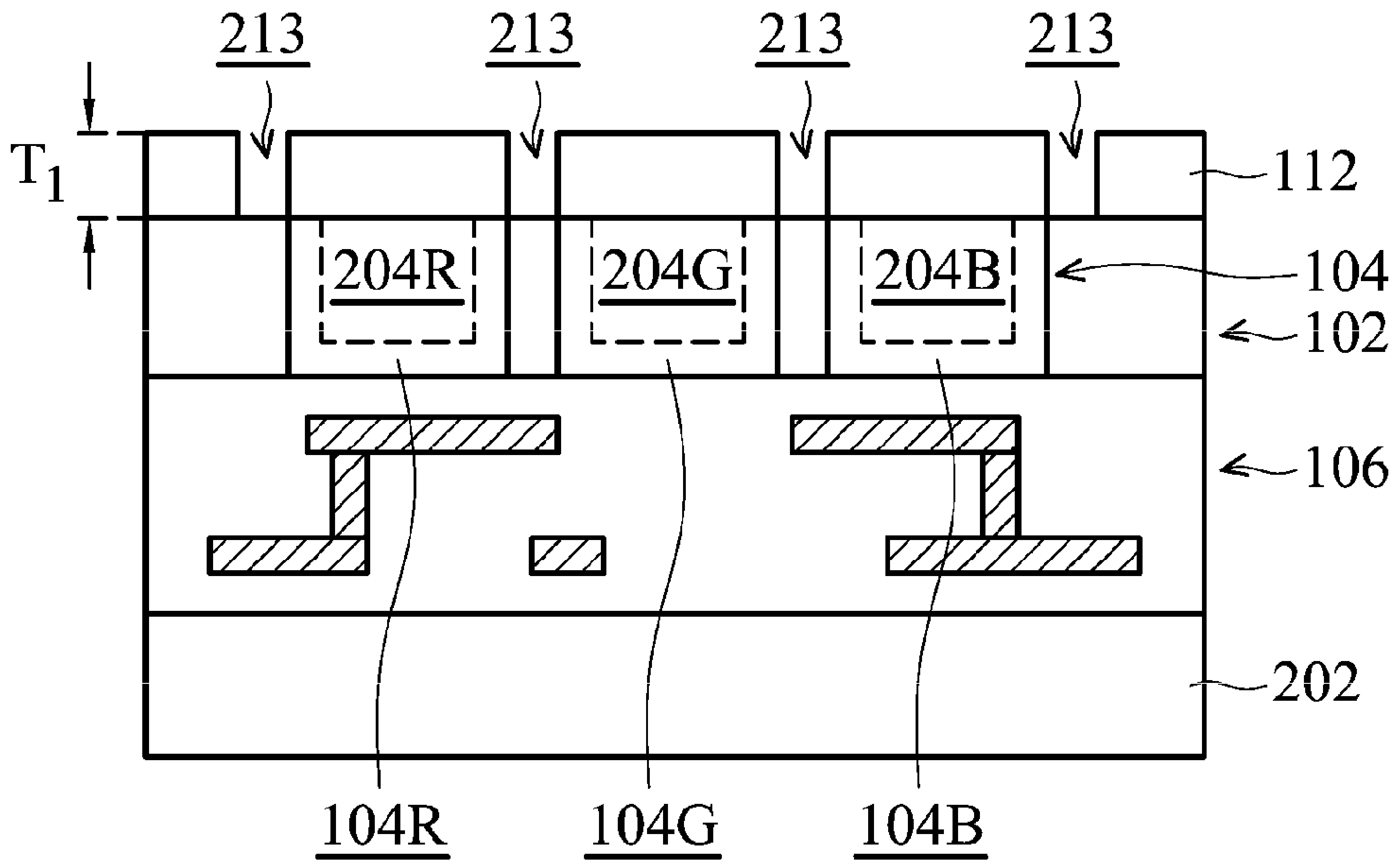
213
213
213
213
T_1
112
204R
204G
204B
104
102
106
202
104R
104G
104B

FIG. 2E

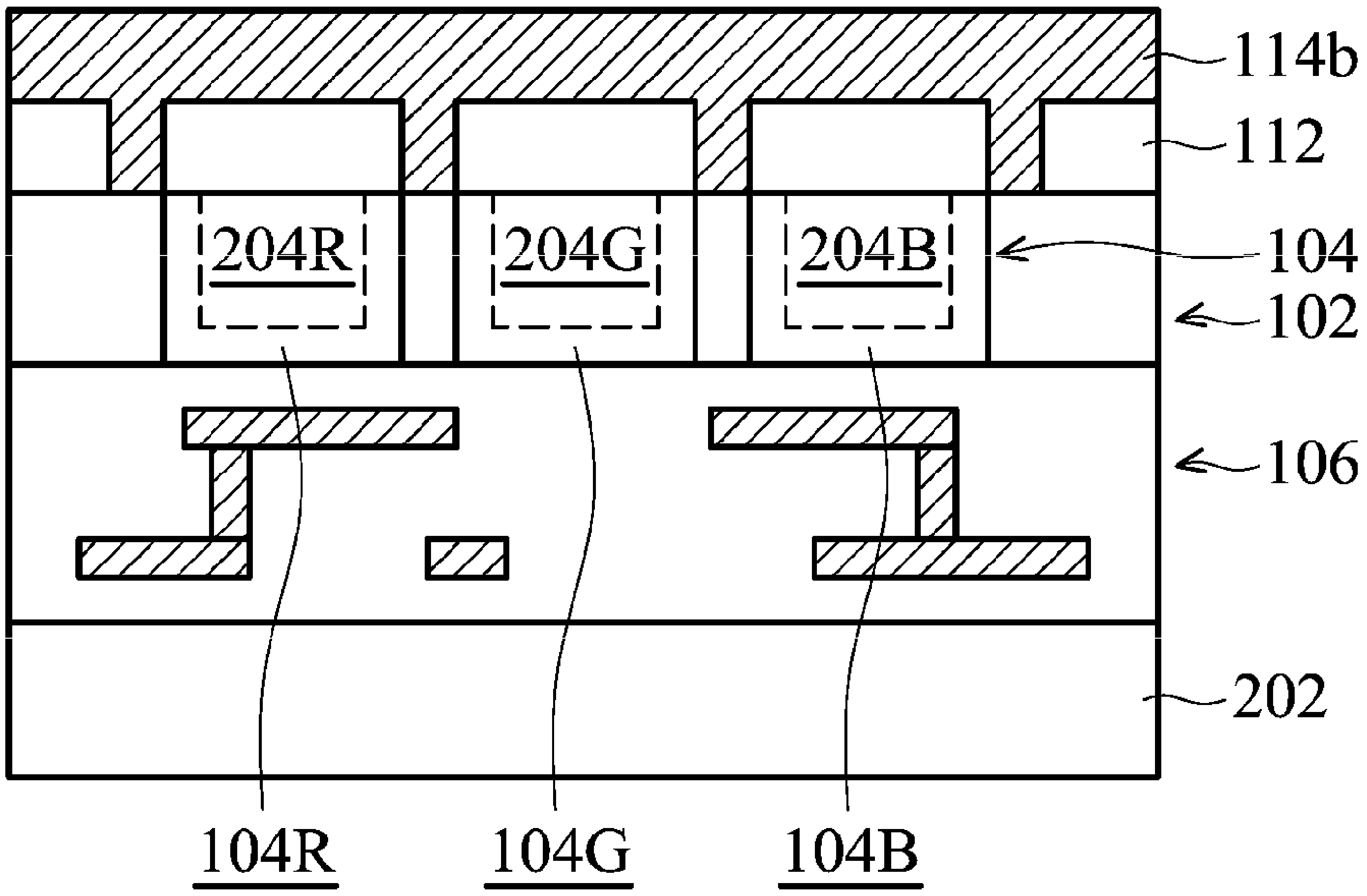
114b
112
204R
204G
204B
104
102
106
202
104R
104G
104B

FIG. 2F

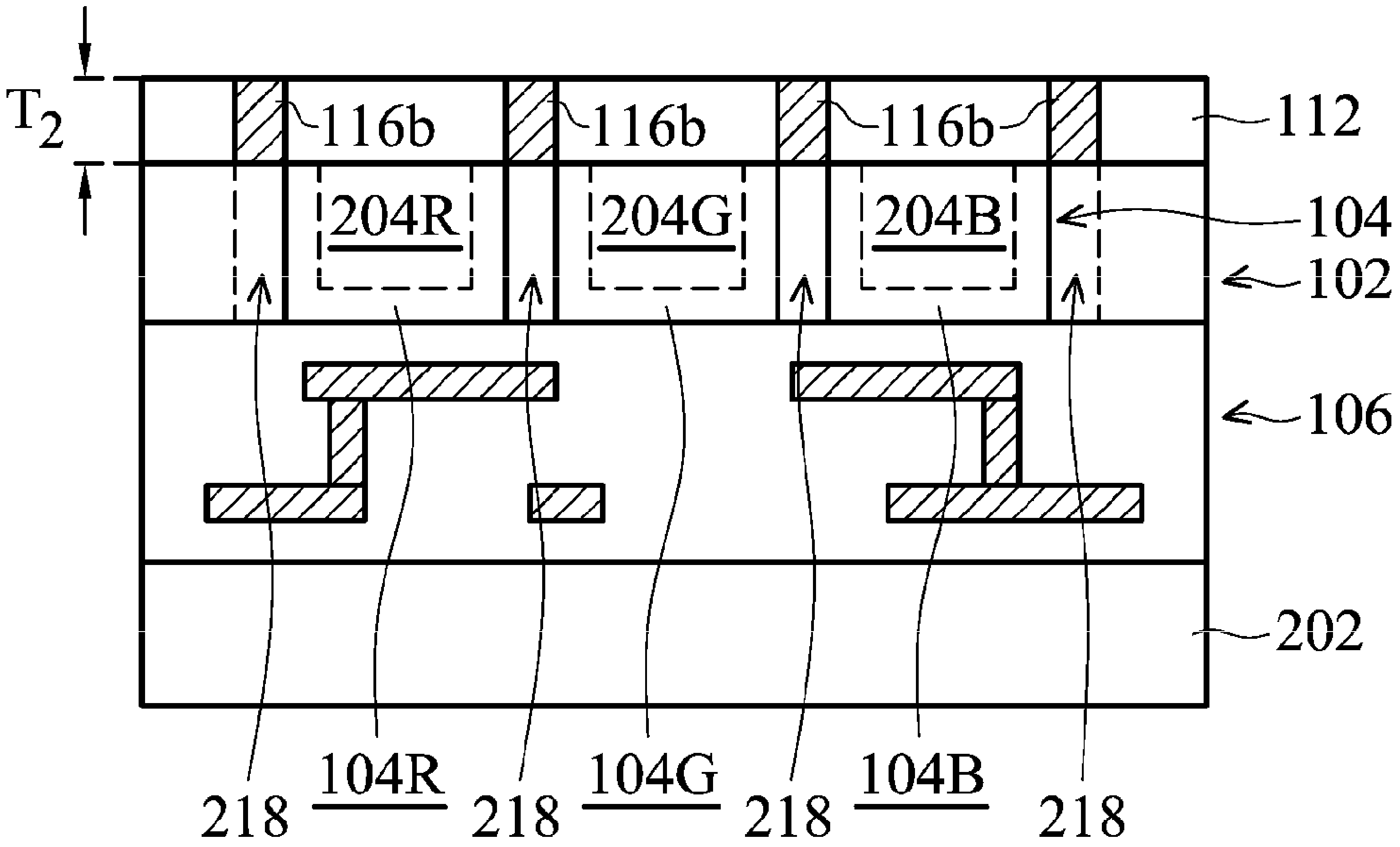
T_2
116b
116b
116b
112
204R
204G
204B
104
102
106
202
218
104R
218
104G
218
104B
218

FIG. 2G

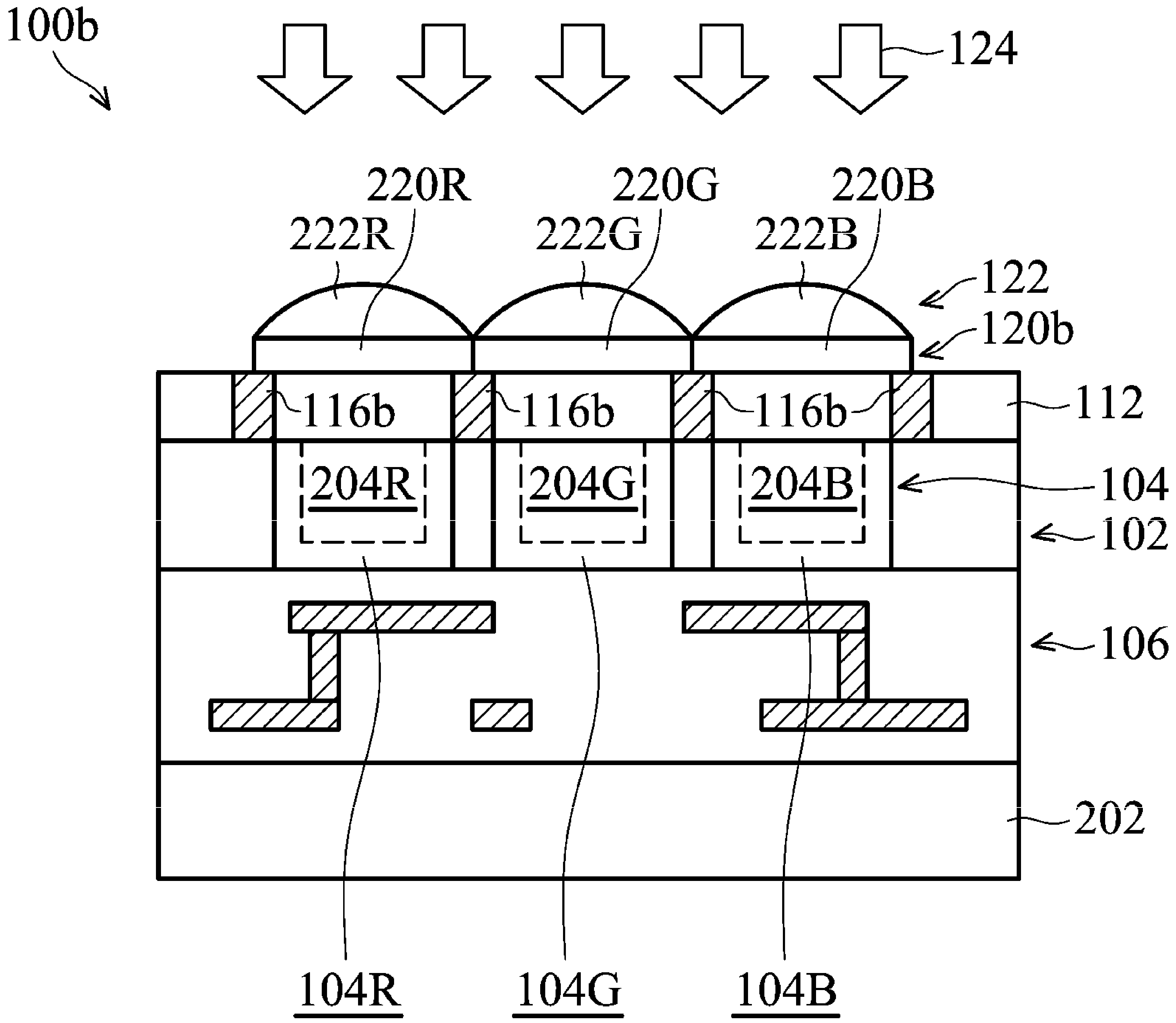
100b
124
220R
220G
220B
222R
222G
222B
122
120b
116b
116b
116b
112
204R
204G
204B
104
102
106
202
104R
104G
104B

FIG. 2H

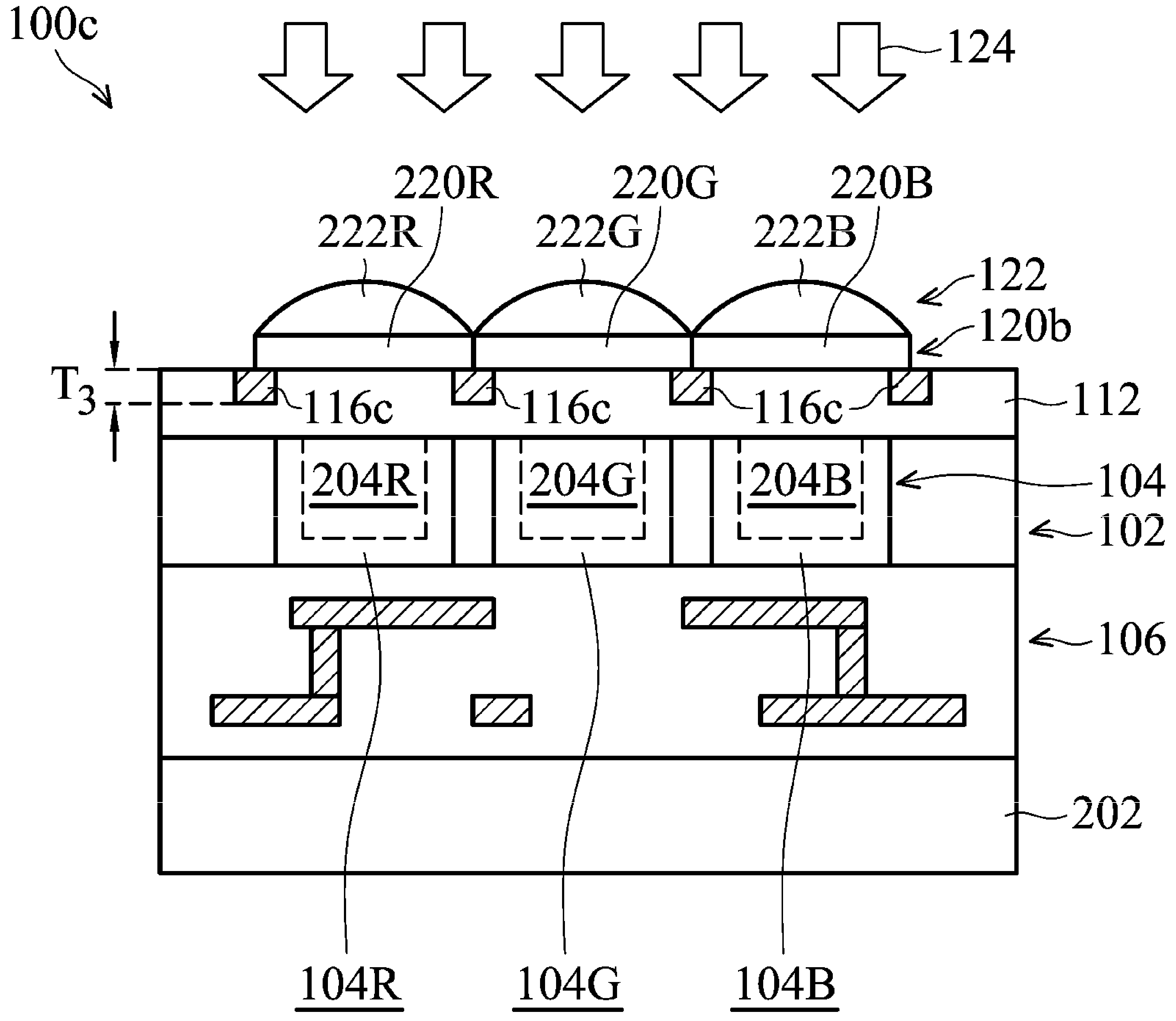
100c
124
220R
220G
220B
222R
222G
222B
122
120b
T3
116c
116c
116c
112
204R
204G
204B
104
102
106
202
104R
104G
104B

FIG. 3

BACKSIDE ILLUMINATED IMAGE SENSOR STRUCTURE

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a Divisional application of co-pending application Ser. No. 14,099,481 filed on Dec. 6, 2013, the entire content of which is hereby incorporated by reference.

BACKGROUND

Integrated circuit (IC) technologies are constantly being improved. Such improvements frequently involve scaling down device geometries to achieve lower fabrication costs, higher device integration density, higher speeds, and better performance.

One of the IC devices is an image sensor device. An image sensor device includes a pixel grid for detecting light and recording intensity (brightness) of the detected light. The pixel grid responds to the light by accumulating charges. The charges can be used (for example, by other circuitry) to provide color in some suitable applications, such as a digital camera.

Common types of pixel grids include a charge-coupled device (CCD) image sensor or complimentary metal-oxide-semiconductor (CMOS) image sensor device. One type of image sensor devices is a backside illuminated (BSI) image sensor device. BSI image sensor devices are used for sensing a volume of light projected towards a backside surface of a substrate. BSI image sensor devices provide a high fill factor and reduced destructive interference, as compared to front-side illuminated (FSI) image sensor devices. In general, BSI technology provides higher sensitivity, lower cross-talk, and comparable quantum efficiency as compared to FSI image sensor devices.

However, although existing BSI image sensor devices and methods of fabricating these BSI image sensor devices have been generally adequate for their intended purposes, as device scaling-down continues, they have not been entirely satisfactory in all respects.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present disclosure, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

FIGS. **1**A to **1**E illustrate cross-sectional representations of various stages of forming a backside illuminated (BSI) image sensor structure in accordance with some embodiments.

FIGS. **2**A to **2**H illustrate cross-sectional representations of various stages of forming a BSI image sensor structure having a metal element embedded in a dielectric layer in accordance with some embodiments.

FIG. **3** illustrates a cross-sectional representation of a BSI sensor structure having a metal element formed in an upper portion of a dielectric layer in accordance with some embodiments.

DETAILED DESCRIPTION

The making and using of various embodiments of the disclosure are discussed in detail below. It should be appreciated, however, that the various embodiments can be embodied in a wide variety of specific contexts. The specific embodiments discussed are merely illustrative, and do not limit the scope of the disclosure.

It is to be understood that the following disclosure provides many different embodiments, or examples, for implementing different features of the disclosure. Specific examples of components and arrangements are described below to simplify the present disclosure. These are, of course, merely examples and are not intended to be limiting. Moreover, the performance of a first process before a second process in the description that follows may include embodiments in which the second process is performed immediately after the first process, and may also include embodiments in which additional processes may be performed between the first and second processes. Various features may be arbitrarily drawn in different scales for the sake of simplicity and clarity. Furthermore, the formation of a first feature over or on a second feature in the description may include embodiments in which the first and second features are formed in direct or indirect contact.

Some variations of the embodiments are described. Throughout the various views and illustrative embodiments, like reference numbers are used to designate like elements. It is understood that additional operations can be provided before, during, and after the method, and some of the operations described can be replaced or eliminated for other embodiments of the method.

Mechanisms for forming an integrated circuit (IC) device structure are provided in accordance with some embodiments of the disclosure. In some embodiments, the IC device is a backside illuminated (BSI) image sensor device. FIGS. **1**A to **1**E illustrate cross-sectional representations of various stages of forming a backside illuminated (BSI) image sensor structure **100***a* in accordance with some embodiments.

Referring to FIG. **1**A, a device substrate **102** having a frontside **103** and a backside **105** is provided. A number of pixels **104** are formed at frontside **103** of device substrate **102** in accordance with some embodiments. Pixels **104** includes pixels **104**R, **104**G, and **104**B corresponding to specific wavelengths. An interconnect structure **106** is formed over frontside **103** of device substrate **102**, as shown in FIG. **1**A in accordance with some embodiments. Interconnect structure **106** includes conductive features **108** formed in a dielectric layer **110**.

A dielectric layer **112** is formed over backside **105** of device substrate **102**, as shown in FIG. **1**A in accordance with some embodiments. In some embodiments, dielectric layer **112** is formed by a CVD process. Next, a metal layer **114***a* is formed over dielectric layer **112**, as shown in FIG. **1**B in accordance with some embodiments. In some embodiments, metal layer **114***a* is made of tungsten, aluminum, or gold. In some embodiments, metal layer **114***a* is formed by sputtering, and therefore dielectric layer **112** is formed between metal layer **114***a* and device substrate **102** to protect device substrate **102** from being damaging by the plasma used during the sputtering process.

Afterwards, metal layer **114***a* is patterned to form metal elements **116***a*. Metal layer **114***a* may be patterned by forming a photoresist layer (not shown) having a number of openings over metal layer **114***a*, etching metal layer **114***a* through the openings, and removing the photoresist layer to form metal elements **116***a*.

However, as shown in FIG. **1**C, the formation of metal elements **116***a* results in a step height H between the top surface of metal elements **116***a* and the top surface of dielectric layer **112**. Step height H may further increase the difficulty of forming a color filter layer over backside **105** of device substrate **102** in the subsequent processes. Therefore, a second dielectric layer **118** is required to form over backside **105** of device substrate **102** to cover metal elements **116***a*. In some embodiments, second dielectric layer **118** is polished. However, even if second dielectric layer **118** is polished, it may still be difficult to make the top surface of second dielectric layer **118** entirely flat, as shown in FIG. 1D in accordance with some embodiments.

Next, a color filter layer **120***a* is formed over second dielectric layer **118**, and a microlens layer **122** is formed over color filter layer **120***a*, as shown in FIG. 1E in accordance with some embodiments. In some embodiments, color filter layer **120***a* is formed by coating a color filter material in a form of liquid on second dielectric layer **118** and curing the color filter material to form color filter layer **120***a*. Therefore, when the top surface of second dielectric layer **118** is not entirely flat, the top surface of color filter layer **120***a* is also rugged in accordance with some embodiments. As a result, microlens layer **122** is formed on the rugged top surface of color filter layer **120***a*, and the performance of BSI image sensor structure **100***a* is affected.

In operation, BSI image sensor structure **100***a* is designed to receive an incident radiation **124** traveling towards backside **105** of substrate **102**, as shown in FIG. 1E in accordance with some embodiments. First, microlens layer **122** directs incident radiation **124** to color filter layer **120***a*. Next, incident radiation **124** passes from color filter layer **120***a* to pixels **104**. In addition, metal elements **116***a* are formed over dielectric layer **112** to prevent incident radiation **124** from passing between each pixel **104**. However, step height H between metal elements **116***a* and dielectric layer **112** may result in the formation of the rugged top surface of color filter layer **120***a*. Therefore, the performance of BSI image sensor structure **100***a* is undermined.

Accordingly, in some embodiments, a BSI image sensor structure **100***b* having a metal element **116***b* embedded in dielectric layer **112** is formed to prevent the formation of step height H. Therefore, the performance of BSI image sensor structure **100***b* is improved. FIGS. **2**A to **2**H illustrate cross-sectional representations of various stages of forming BSI image sensor structure **100***b* in accordance with some embodiments. However, it should be noted that BSI image sensor structure **100***b* illustrated in FIGS. **2**A to **2**H has been simplified for the sake of clarity so that concepts of the present disclosure can be better understood. Therefore, in some other embodiments, additional features are added in BSI image sensor structure **100***b*, while some of the elements are replaced or eliminated.

For example, BSI image sensor structure **100***b* may be an integrated circuit (IC) chip, system-on-chip (SoC), or a portion thereof, which includes various passive and active microelectronic devices, such as resistors, capacitors, inductors, diodes, metal-oxide-semiconductor field effect transistors (MOSFET), complementary metal-oxide-semiconductor (CMOS) transistors, high-voltage transistors, high-frequency transistors, or other applicable components. In addition, it should be noted that different embodiments may have different advantages than those described herein, and no particular advantage is necessarily required of any embodiment.

As shown in FIG. **2**A, device substrate **102** and interconnect structure **106** formed over device substrate **102** are provided in accordance with some embodiments. Substrate **102** may be a semiconductor wafer such as a silicon wafer. Alternatively or additionally, device substrate **102** may include elementary semiconductor materials, compound semiconductor materials, and/or alloy semiconductor materials. Examples of the elementary semiconductor materials may be, but are not limited to, crystal silicon, polycrystalline silicon, amorphous silicon, germanium, and/or diamond. Examples of the compound semiconductor materials may be, but are not limited to, silicon carbide, gallium arsenic, gallium phosphide, indium phosphide, indium arsenide, and/or indium antimonide. Examples of the alloy semiconductor materials may be, but are not limited to, SiGe, GaAsP, AlInAs, AlGaAs, GaInAs, GaInP, and/or GaInAsP.

Device substrate **102** may be a p-type or an n-type substrate depending on the design requirements of BSI image sensor structure **100***b*. Device substrate **102** may also include isolation features (not shown), such as shallow trench isolation (STI) and/or local oxidation of silicon (LOCOS) features, to separate the pixels (discussed below) and/or other devices formed on device substrate **102**. In some embodiments, device substrate **102** is a device wafer.

Pixels **104** are formed at frontside **103** of device substrate **102**. In some embodiments. pixels **104** include pixels **104**R, **104**G, and **104**B corresponding to specific wavelengths. For example, pixels **104**R, **104**G, and **104**B respectively correspond to a range of wavelengths of red light, green light, and blue light. Therefore, each of pixels **104**R, **104**G, and **104**B may detect the intensity (brightness) of a respective range of wavelengths. The term “pixel” refers to a unit cell containing features (for example, circuitry including a photodetector and various semiconductor devices) for converting electromagnetic radiation into electrical signals. Pixels **104**R, **104**G, and **104**B may include various features and circuitry allowing them to detect the intensity of incident radiation.

In some embodiments, pixels **104**R, **104**G, and **104**B are photodetectors, such as photodiodes including light-sensing regions **204**R, **204**G, and **204**B, respectively. Light-sensing regions **204**R, **204**G, and **204**B may be doped regions having n-type and/or p-type dopants formed in device substrate **102**. Light-sensing regions **204**R, **204**G, and **204**B may be formed by an ion implantation process, diffusion process, or other applicable processes.

Interconnect structure **106** is formed over frontside **103** of device substrate **102** and includes dielectric layer **110** and conductive features **108** formed in dielectric layer **110**. Conductive features **108** may be configured to connect various features or structures of BSI image sensor **100***b*. For example, conductive features **108** are used to interconnect the various devices formed on device substrate **102**. Conductive features **108** may be vertical interconnects, such as vias and/or contacts, and/or horizontal interconnects, such as conductive lines. In some embodiments, conductive features **108** are made of conductive materials, such as aluminum, aluminum alloy, copper, copper alloy, titanium, titanium nitride, tungsten, polysilion, or metal silicide.

In some embodiments, dielectric layer **110** includes interlayer (or inter-level) dielectric (ILD) layers or inter-metal dielectric (IMD) layers. In some embodiments, dielectric layer **110** includes multilayers made of multiple dielectric materials, such as silicon oxide, silicon nitride, silicon oxynitride, tetraethoxysilane (TEOS), phosphosilicate glass (PSG), borophosphosilicate glass (BPSG), low-k dielectric material, other applicable dielectric materials. Examples of low-k dielectric materials include, but are not limited to, fluorinated silica glass (FSG), carbon doped silicon oxide, amorphous fluorinated carbon, parylene, bis-benzocyclobutenes (BCB), or polyimide. Dielectric layer **110** may be formed by a chemical vapor deposition (CVD), physical vapor deposition, (PVD), atomic layer deposition (ALD), spin-on coating, or other applicable processes.

Referring to FIG. **2**B, device substrate **102** is bonded to a carrier substrate **202** in accordance with some embodiments.

An adhesive layer (not shown) formed on interconnect structure **106** over frontside **103** of device substrate **102** may be bonded to another adhesive layer (not shown) formed on carrier substrate **202**. As shown in FIG. **2**B, device substrate **102** is bonded to carrier substrate **202** through its frontside **103**.

After device substrate **102** is bonded to carrier substrate **202**, backside **105** of device substrate **102** is polished to thin down device substrate **102**, as shown in FIG. **2**C in accordance with some embodiments. In addition, device substrate **102** may be thinned down from its backside **105** to expose light-sensing regions **204**R, **204**G, and **204**B. In some embodiments, device substrate **102** is polished by a chemical mechanical polishing (CMP) process.

Next, dielectric layer **112** is formed over backside **105** of device substrate **102** to cover exposed light-sensing regions **204**R, **204**G, and **204**B, as shown in FIG. **2**D in accordance with some embodiments. In some embodiments, dielectric layer **112** is an oxide layer. In some embodiments, dielectric layer **112** is formed by a chemical vapor deposition (CVD) process.

Next, dielectric layer **112** is patterned to form trenches **213** in dielectric layer **112**, as shown in FIG. **2**E in accordance with some embodiments. In some embodiments, the method for forming trenches **213** includes forming a photoresist layer (not shown) having openings over dielectric layer **112**, etching dielectric layer **112** through the openings to form trenches **213**, and removing the photoresist layer. In addition, trenches **213** are formed through dielectric layer **112** in accordance with some embodiments. That is, the thickness of trench **213** is substantially equal to the thickness of dielectric layer **112**. In some embodiments, trench **213** has a thickness T_1 of no less than 100 A, such as about 100 A. When thickness T_1 is too small, metal elements **116***b* formed in the sequential processes may also be too short to block incident radiation **124** effectively.

After trenches **213** are formed in dielectric layer **112**, a metal layer **114***b* is formed in trenches **213** and over dielectric layer **112**, as shown in FIG. **2**F in accordance with some embodiments. In some embodiments, metal layer **114***b* is a copper layer formed by plating. The plating process used to form metal layer **114***b* will not damage device substrate **102**, and therefore, device substrate **102** does not need to be protected by dielectric layer **112** during the plating process. That is, metal layer **114***b* can be formed directly on the top surface of device substrate **102** in trenches **213** without damaging device substrate **102**.

After trenches **213** are filled with metal layer **114***b*, metal layer **114***b* over dielectric layer **112** is polished, as shown in FIG. **2**G in accordance with some embodiments. In some embodiments, metal layer **114***b* is polished by a CMP process to expose the top surface of dielectric layer **112** and to form metal elements **116***b*. Metal elements **116***b* is configured to block incident radiation from passing through, and therefore areas below metal elements **116***b* are called light blocking areas **218**. In some embodiments, pixels **104** are separated by light blocking areas **218**.

In some embodiments, metal element **116***b* has a thickness T_2 of no less than 100 A, such as about 100 A. When thickness T_2 is too small, metal elements **116***b* may not be able to block the radiation (light) effectively. In some embodiments, thickness T_2 is substantially equal to thickness T_1.

As shown in FIG. **2**H, metal elements **116***b* are embedded in dielectric layer **112**, and therefore no step height is formed. Accordingly, color filter layer **120***b* formed over dielectric layer **112** has a flat top surface, as shown in FIG. **2**H in accordance with some embodiments. Therefore, microlens layer **122** is formed over the flat top surface of color filter layer **120***b*.

In some embodiments, color filter layer **120***b* includes color filters **220**R, **220**G, and **220**B. Incident radiation **124** may be filtered by color filter **220**R, and the filtered incident radiation **124**, such as being transformed into a red light, may reach pixel **104**R. Similarly, incident radiation **120** filtered by color filter **220**G, such as being transformed into a green light, may reach pixel **104**G, and incident radiation **124** filtered by color filter **220**B, such as being transformed in to a blue light, may reach pixel **104**B. In some embodiments, each of color filters **220**R, **220**G, and **220**B is aligned with its respective, corresponding pixels **104**R, **104**G, and **104**B.

In some embodiments, color filters **220**R, **220**G, and **220**B are made of a dye-based (or pigment-based) polymer for filtering out a specific frequency band. In some embodiments, color filters **220**R, **220**G, and **220**B are made of a resin or other organic-based materials having color pigments.

In some embodiments, microlens layer **122** formed on color filter layer **220***b* includes microlenses **222**R, **222**G, and **222**B. As shown in FIG. **2**F, each of microlenses **222**R, **222**G, and **222**B is aligned with one of the corresponding color filters **220**R, **220**G, and **220**B, and therefore is aligned with one of the corresponding pixels **104**R, **104**G, and **104**B. However, it should be noted that microlenses **222**R, **222**G, and **222**B may be arranged in various positions in various applications. In addition, microlenses **220**R, **220**G, and **220**B may have a variety of shapes and sizes, depending on the refraction index of materials of microlenses **220**R, **220**G, and **220**B and/or the distance between microlenses **220**R, **220**G, and **220**B and light-sensing regions **204**R, **204**G, and **204**B.

In operation, BSI image sensor structure **100***b* is designed to receive incident radiation **124** traveling towards backside **105** of device substrate **102**, as shown in FIG. **2**H in accordance with some embodiments. First, microlens layer **122** directs incident radiation **124** to color filter layer **120***b*. Next, incident radiation **124** passes from color filter layer **120***b* to pixels **104**. In some embodiments, incident radiation **124** is visible light, infrared (IR) light, ultraviolet (UV) light, an X-ray, or a microwave.

FIG. **3** illustrates a cross-sectional representation of a BSI sensor structure **100***c* in accordance with some embodiments. BSI sensor structure **100***c* is similar to BSI sensor structure **100***b* except metal elements **116***c* are formed in an upper portion of dielectric layer **112** instead of passing through dielectric layer **112**.

In some embodiments, metal element **116***c* has a thickness T_3 of no less than 100 A, such as about 100 A. Although metal elements **116***c* are not formed through dielectric layer **112**, thickness T_3 still need to be thick enough, or incident radiation **124** can not be blocked effectively by metal elements **116***c*.

As described previously, metal elements **116***b* and **116***c* are formed in trenches **213** of dielectric layer **112**. Therefore, there is no step height H between the top surface of metal elements **116***b* (or **116***c*) and the top surface of dielectric layer **112**. Accordingly, color filter layer **120***b* formed on dielectric layer **112** has a flat top surface (as shown in FIGS. **2**H and **3**), instead of the rugged top surface of color filter layer **120***a* as shown in FIG. **1**E. Therefore, the performance of BSI image sensor structures **100***b* and **100***c* is improved.

In addition, metal elements **116***b* are formed by plating in accordance with some embodiments. Therefore, compared to metal elements **116***a* formed by PVD, such as sputtering, metal elements **116***b* can be formed directly on device substrate **102** without using dielectric layer **112** between metal elements **116***b* and device substrate **102** as a protection. That is, metal elements **116***b* are formed through dielectric layer **112**. In addition, metal elements **116***a* are made of copper in accordance with some embodiments. Therefore, the formation and processing of metal elements **116***a* becomes easier and costs less.

Embodiments of mechanisms for a BSI image sensor structure are provided. The BSI image sensor structure includes a device substrate and pixels formed in the device substrate. A metal element embedded in a dielectric layer is formed over a backside of the device substrate. More specifically, the metal element is formed in a trench of the dielectric layer. Therefore, there is no step height between the top surface of the metal element and the top surface of the dielectric layer. Accordingly, a color filter layer formed on the dielectric layer over pixels has a flat top surface, and the performance of the BSI image sensor structure is improved.

In some embodiments, a backside illuminated image sensor structure is provided. The backside illuminated image sensor structure includes a device substrate having a frontside and a backside and pixels formed at the frontside of the substrate. The backside illuminated image sensor structure further includes a metal element formed in a dielectric layer over the backside of the substrate and a color filter layer formed over the dielectric layer. In addition, the metal element is configured to form a light blocking area in the device substrate and is made of copper.

In some embodiments, a backside illuminated image sensor structure is provided. The backside illuminated image sensor structure includes a substrate having a frontside and a backside and a plurality of pixels formed at the frontside of the substrate. The backside illuminated image sensor structure further includes a dielectric layer formed over a backside of the substrate and metal elements formed through the dielectric layer. The backside illuminated image sensor structure further includes a color filter layer formed over the dielectric layer.

In some embodiments, a backside illuminated image sensor structure is provided. The backside illuminated image sensor structure includes a substrate and light sensing regions formed in the substrate. The backside illuminated image sensor structure further includes an interconnect structure formed over a frontside of the substrate and a dielectric layer formed over a backside of the substrate. The backside illuminated image sensor structure further includes metal elements formed in the dielectric layer and a color filter layer formed over the dielectric layer. In addition, the metal elements are made of copper.

Although embodiments of the present disclosure and their advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the disclosure as defined by the appended claims. For example, it will be readily understood by those skilled in the art that many of the features, functions, processes, and materials described herein may be varied while remaining within the scope of the present disclosure. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure of the present disclosure, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed, that perform substantially the same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized according to the present disclosure. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps.

What is claimed is:

1. A backside illuminated image sensor structure comprising:

a device substrate having a frontside and a backside;

a plurality of pixels formed at the frontside of the device substrate and exposed from the backside of the device substrate;

a dielectric layer formed on the backside of the device substrate and in direct contact with the pixels;

a metal element embedded in the dielectric layer; and

a color filter layer formed over the dielectric layer,

wherein the metal element is made of copper and is in direct contact with the device substrate.

2. The backside illuminated image sensor device structure as claimed in claim **1**, wherein the metal element has a thickness of no less than 100 Å.

3. The backside illuminated image sensor device structure as claimed in claim **1**, wherein the dielectric layer is an oxide layer.

4. The backside illuminated image sensor device structure as claimed in claim **1**, further comprising:

a microlens layer formed over the color filter layer.

5. The backside illuminated image sensor device structure as claimed in claim **1**, further comprising:

an interconnect structure formed over the frontside of the device substrate.

6. A backside illuminated image sensor structure comprising:

a substrate having a frontside and a backside;

a plurality of pixels formed at the frontside of the substrate;

an oxide layer having trenches formed over a backside of the substrate and in direct contact with the pixels;

metal elements formed in the trenches of the oxide layer; and

a color filter layer formed over the oxide layer,

wherein the trenches of the oxide layer are fully filled with the metal elements, and the pixels are exposed from both the frontside and the backside of the substrate and the metal elements are in contact with the backside of the substrate.

7. The backside illuminated image sensor device structure as claimed in claim **6**, wherein the metal elements are made of copper.

8. The backside illuminated image sensor device structure as claimed in claim **6**, wherein the metal element has a thickness of no less than 100 Å.

9. The backside illuminated image sensor device structure as claimed in claim **6**, further comprising:

an interconnect structure formed over the frontside of the substrate.

10. The backside illuminated image sensor device structure as claimed in claim **6**, wherein the oxide layer is in direct contact with the backside of the substrate.

11. The backside illuminated image sensor device structure as claimed in claim **6**, further comprising:

a microlens layer formed over the color filter layer.

12. The backside illuminated image sensor device structure as claimed in claim **6**, wherein top surfaces of the metal elements are level with a top surface of the oxide layer.

13. A backside illuminated image sensor structure comprising:

a substrate having a frontside and a backside;

light sensing regions formed in the substrate, wherein the light sensing regions are exposed from both the frontside and the backside of the substrate;

an interconnect structure formed over the frontside of the substrate;

a dielectric layer formed on the backside of the substrate and in direct contact with the light sensing regions;

metal elements embedded in the dielectric layer; and

a color filter layer formed over the dielectric layer,

wherein the metal elements are made of copper and top surfaces of the metal elements are level with a top surface of the dielectric layer and in contact with the color filter layer, and bottom surfaces of metal elements are in contact with the backside of the substrate.

14. The backside illuminated image sensor device structure as claimed in claim **13**, wherein each metal element has a thickness of no less than 100 Å.

15. The backside illuminated image sensor device structure as claimed in claim **13**, wherein the dielectric layer is an oxide layer.

16. The backside illuminated image sensor device structure as claimed in claim **13**, further comprising:

a microlens layer formed over the color filter layer.

17. The backside illuminated image sensor device structure as claimed in claim **13**, wherein the metal elements are directly formed on the backside of the substrate.

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